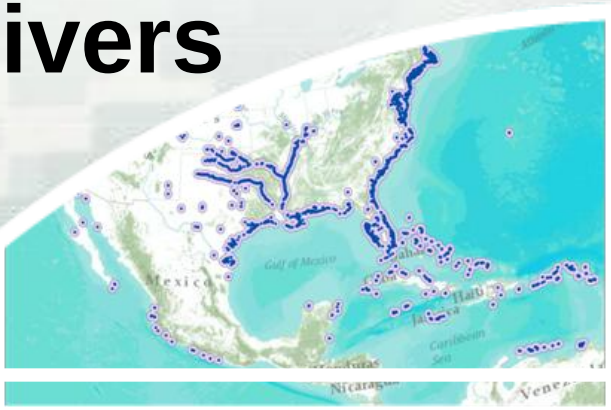
USACE Dam Operations and Habitat Management for Interior Least Terns Along Inland Rivers



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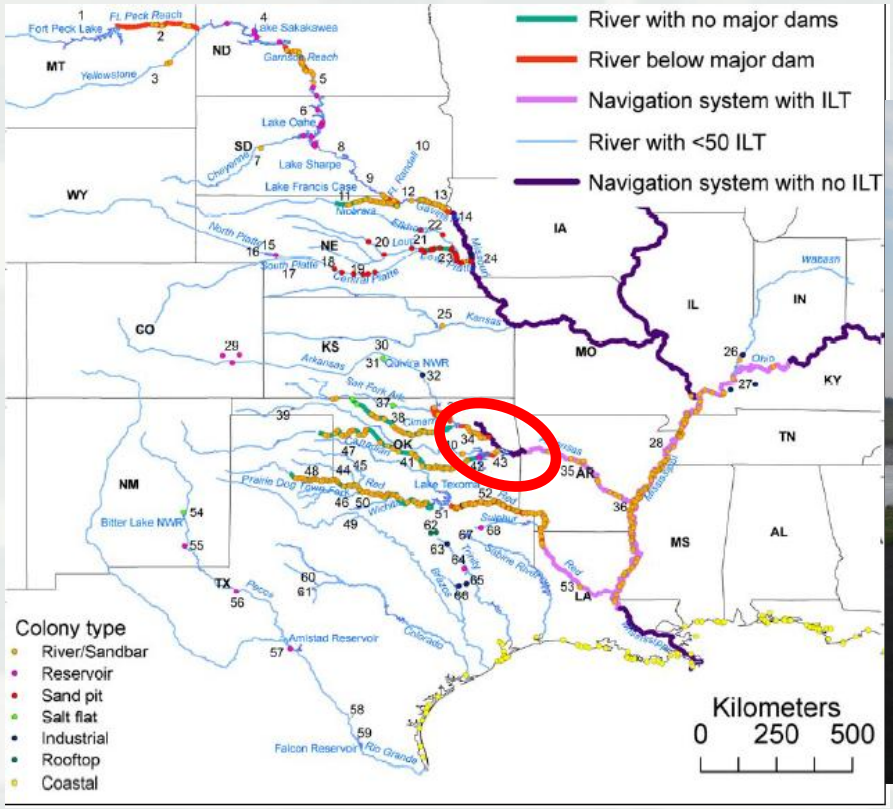
Objectives

- Describe how USACE dam operations may impact habitats creation and reproductive success of the endangered Least Terns.
- USACE dam operations along the Keystone River, AR, provide an example for creating river sand bars as nesting habitat for the endangered Interior Least Tern.
- Data collected below Keystone Dam used to create TernCOLONY, a Individual-Based Modeling (IBM) approached that may be used to predict impacts of dam operations on nesting birds downstream for many different river systems.

Keystone Dam, Arkansas River

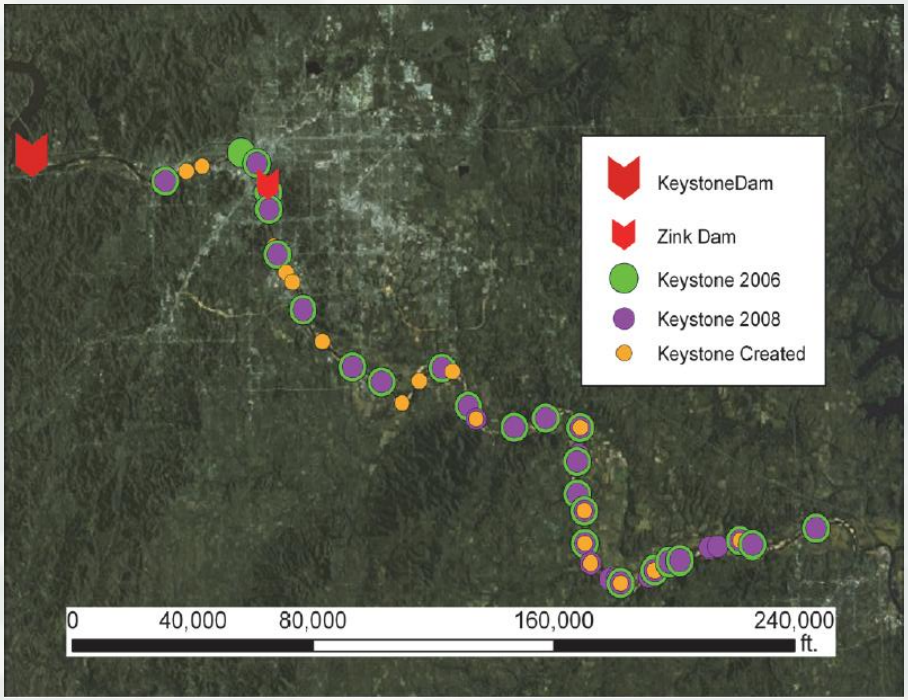


Interior Least Tern Listed by USFWS as Endangered in 1985; Habitat loss by river channelization, dam operations (releases), water removal through irrigation for agriculture, and bank stabilization.

1). Channelization reduces natural formation of sand bars,

2). Dam releases may flood existing nests and young,

3). Droughts may degrade habitat, and open sand bars to access by predators.



Factors Contributing to Reproduction Failures by the Interior Least Tern Along the Arkansas River:

1) Heavy rains and/or untimely dam releases may greatly reduce amount of existing sand bar habitat for nesting.

2) Mid-season water releases may cause nest flooding.

3) Low water levels, and degraded habitat may increase predation.

Research on Nesting Interior Least Terns in 2008

1). Habitat availability and nesting of terns studied in 2008, After 2 years with planned heavy dam releases (>50,000 cfs) >3 weeks)(Lott and Wiley 2012).

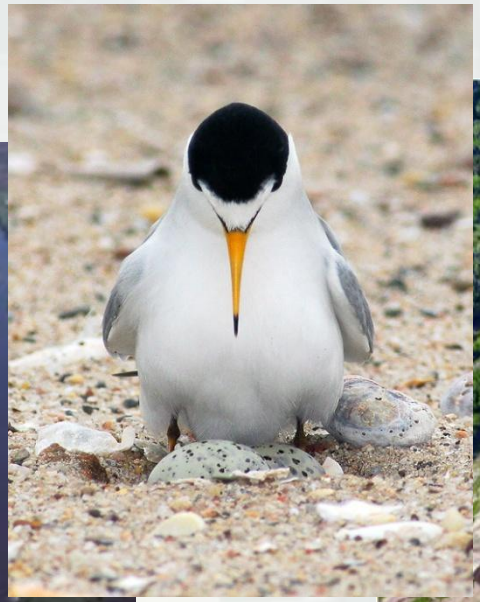
2). Results were compared to simulated degraded habitat in ArcGIS descriptions based on USFWS Biological Opinion of Arkansas River.

3). Habitat conditions are described relative to long-term Hydrographs that reflect Keystone Dam operations for Hydropower and flood control.

4). Individual-Based Model, TernCOLONY used to evaluate impacts of dam operations on Tern reproduction.

Large water releases at the Keystone Dam in 2007 and 2008, created numerous large, high-elevation sand bars that provide the best nesting conditions for Interior Least Tern.

The number and conditions of newly created sand bars were quantified in 2008.



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Effects of Dam Operations on Least Tern Nesting Habitat and Reproductive Success Below Keystone Dam on the Arkansas River

Casey A. Lott and Robert L. Wiley

December 2012

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Developing and Testing TernCOLONY 1.0: An Individual-based Model of Least Tern Reproduction

Casey A. Lott, Steven F. Railsback, Colin J.R. Sheppard, and Michael C. Koohafkan

June 2013

http://www.leasttern.org/

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an individual-based model of Least Tern reproduction

The TernCOLONY model simulates breeding seasons for virtual populations of Least Terns nesting on river sandbars.

Users design their own simulation experiments to understand which factors may limit tern reproductive success (e.g., predators, floods) or to compare different management approaches for increasing reproductive output.

Getting Started

Tutorials

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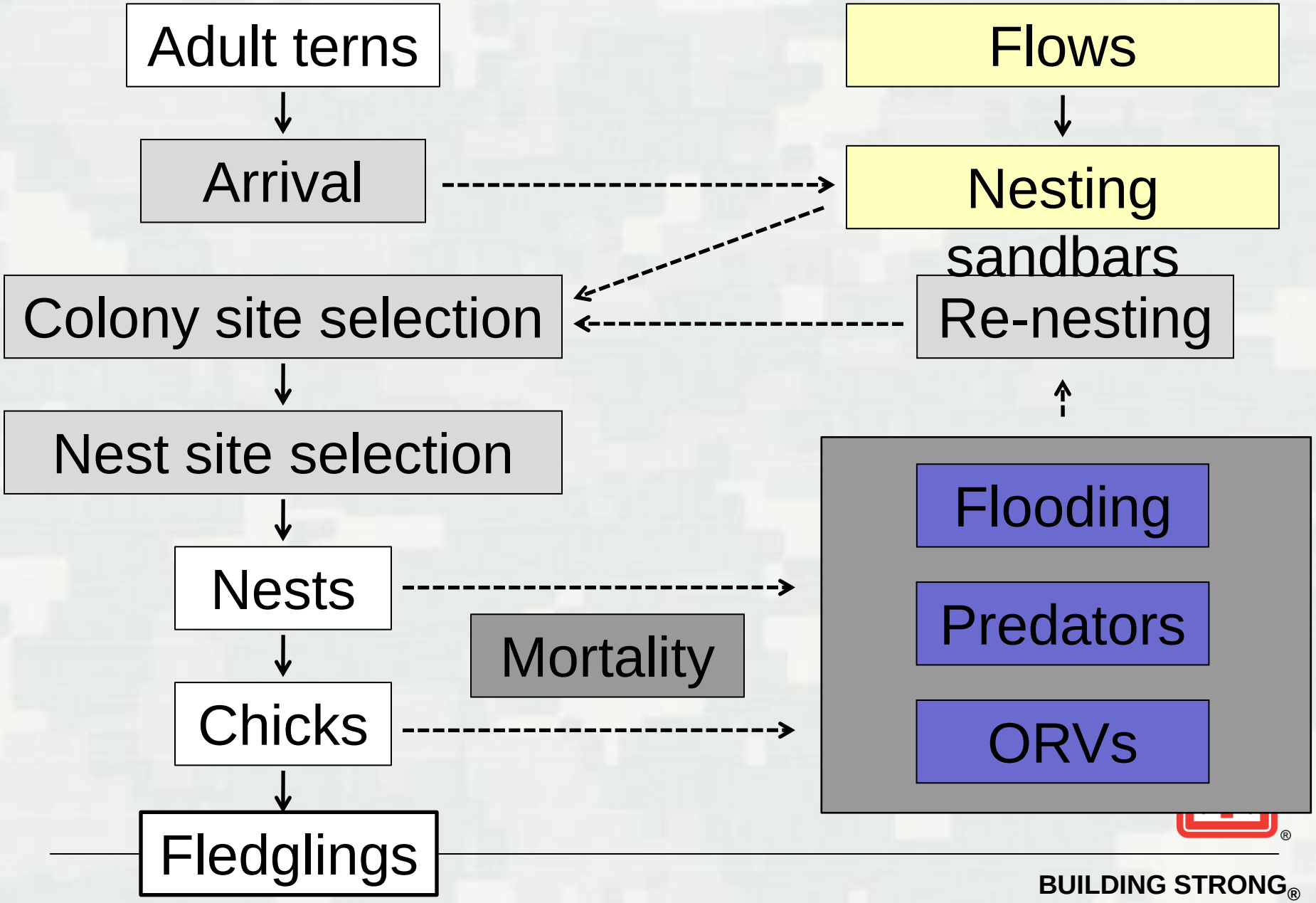
Basic IBM Least Tern Model Structure



Breeding Biology

TernCOLONY is a structurally realistic model of Least Tern reproduction.

Least Terns are colonial, fish-eating birds that nest in large open areas on rivers and coasts. Each spring, adult tern
Distribution) and form pairs near (or at) eventual breeding colonies. After pair formation, females lay 1-3 eggs on
clutches are complete, eggs are incubated for ~20 days. If eggs survive to hatch, newly hatched chicks can move a
and find cover under driftwood or in vegetation. Tern chicks are fed by their parents until ~20 days of age, at whic
considered "fledglings." Fledglings remain dependent on their parents until fall migration, but both fledglings and
colony within 1-4 weeks of fledging. If nesting attempts fail early in the breeding season, adult terns may re-nest (
different one).

Distribution

Least Terns have a large geographic range that includes breeding areas in many US states and a number of countries in Lati
Caribbean. The non-breeding distribution of Least Terns is mostly south of the US border and includes areas as far south as

Least Terns breed on rivers within the interior United States, on beaches along the Pacific Coast in California and Western M
Coast from Maine to Florida, throughout the Caribbean and around the Gulf of Mexico in sandy areas from Florida south to B
California and Interior US (rivers >50km from the Gulf of Mexico) populations are federally listed. The interior population co
with >60% of the population occuring on the Lower Mississippi River (from near the confluence of the Ohio River to near Ba
Other large tern interior populations occur on the Red, Arkansas, Canadian, and Cimarron Rivers within the southern Great Pl
of the Missouri and Platte Rivers in the northern Great Plains. Nearly 90% of the interior population breeds on river sandbars,
on reservoir islands and shorelines, salt flats near rivers, at industrial sites, and on a small number of rooftops. Along the Atla
coasts, where sandy beaches have extremely high human use, Least Terns frequently nest on rooftops.

Population Ecology

TernCOLONY was designed to investigate factors that may limit Least Tern reproduction. However, Least Terns a other migrants, population regulation may occur within any portion of the annual cycle.

While many studies have examined Least Tern breeding biology, reproductive performance, or threats within bree focused on migration or "wintering" areas. In breeding areas, reproduction may be limited by habitat amount, habi During the non-breeding season, other factors may limit tern survival, and Least Tern population trajectories may any time of the year. On large rivers, Least Tern distribution and reproductive success is largely tied to conditions operations or system engineering may exert a strong effect on habitat quality and distribution. Terns are capable of possible that local populations on any one river are affected by reproductive output or habitat conditions on adjace

Human Disturbance

TernCOLONY represents only one type of human disturbance, disturbance from off-road vehicles (ORVs). ORVs a that appear at sites, may stay for more than one day, and may crush eggs or chicks when they are present. Indirec predation rates when ORVs are present or complete avoidance of otherwise suitable sandbars due to ORV presenc TernCOLONY (although strategies for exploring these types of effects are suggested in model documentation).

While many types of human disturbance are common at coastal Least Tern colonies (e.g., terns are regularly distu beach cleaning equipment), these types of disturbance are far less common on large rivers (due to the low density However, on many Great Plains rivers, recreational use of off-road vehicles on sandbars is common, particularly o

Flooding

TernCOLONY allows users to choose from a variety of different annual flow inputs for simulations, representing c
Least Tern breeding season. Some types of water years present little flooding risk to nesting terns (e.g., drought ye
other years present considerable flooding risk to nesting terns (e.g., wet years that result in heavy run-off or large
depends on initial habitat conditions. When terns are nesting on high sandbars, they are much less at risk than whe

Large floods (either from dam releases during flood control operations, uncontrolled tributary runoff, or both) crea
flooding risk for nesting terns (in subsequent years, during normal reservoir operations, after habitat-forming flows
(or dam releases) may create large sandbars that will persist for many years after the high flow event. In contrast, b

Nesting Habitat

TernCOLONY allows users to simulate least tern breeding seasons with inputs for either high-quality habitat cond that typically occur after a large, habitat-forming flood) or degraded habitat conditions (e.g., smaller and lower s vegetation). In addition to these baseline conditions, users may add "restoration" sandbars to simulations to see h respond to different strategies of mechanical habitat creation.

Nearly 90% of the interior population of Least Terns nests on sandbars on large rivers. Terns tend to select sandba (relative to local waterlines) than other sandbars in the region, and sandbars with tern colonies typically have large vegetation and distant from large trees. Frequent flooding removes pioneering vegetation from sandbars and depos

Predators

Rather than representing the large number of predator species that actually prey on least terns, TernCOLONY rep types: a nest predator, a chick predator, and a predator of adult terns. Predators arrive at tern colonies, destroy e what type they are), and either leave the sandbar or stay another day.)

Predators tend to be the most consistent and widespread source of mortality for least tern eggs and chicks. Adult n breeding season is typically rare; however, in some cases, avian predators can kill several incubating adult terns at predators find tern colonies, they tend to destroy more than 1 egg or chick and often persist at a site for several day destroying the colony completely). Predation at tern colonies on river sandbars tends to be highest when vegetatio

Model Documentation

This page provides documentation for the TernCOLONY model. Some of these documents will be revised as journal artic
site will be updated.

- The development and testing of TernCOLONY- 194pp.
- TernCOLONY model description- 57pp.
- TernCOLONY web-version user's guide

- Measuring Least Tern sandbar nesting habitat- 113pp.
- Script for creating TernCOLONY habitat inputs- 19pp.
- Sandbar creator script supporting files

- Preparing TernCOLONY model inputs- 24pp.

Conclusions From Habitat Data and TernCOLONY Simulations

- High flows in 2007-2008 created >450 acres of high elevation sandbars; lower dam releases resulted in lower amount of habitat creation.
- Low flow years resulted in highest predation; highest mid-season releases resulted in highest reproductive failures.
- Periods of high floods have mixed results; if water receded, terns may have opportunity to re-nest, if not, then entire season could be lost.

Conclusions, continued

- When habitat conditions are good, normal dam operations have minimal impacts on nesting terns.
- Most degraded conditions exist when water levels are low, most sand bars are low elevation, and nesting habitat is degraded by encroaching vegetation.
- Active management may only be necessary when habitat conditions are degraded; best management options include habitat creation with predator control – all effective management scenarios involved predator control – habitat creation insufficient alone to increase fledgling production.
- Monitoring and quantifying habitat conditions is necessary during high-flow events and when conditions are degraded: data will increase power of model

Acknowledgements

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- Habitat work conducted by David Miller and Assoc.; Interior Least Tern population modeling developed in collaboration with the U.S Army Engineering Research and Development Center, Penn State University, and Lang, Railsback and Associates.